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Global Panopticon

Professor Chris Chatwin

School of Engineering & Design
University of Sussex

IET – The Hawth, Crawley – 8th October 2009

Summary

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Credits: Young, Birch, 2020 Imaging Ltd

Panopticon since 5000 BC – It’s a mental state

Contemporary Panopticon Infrastructure & Technologies

Video Surveillance

Biometrics

Label technologies

Conclusion

How was it done in the past?
The all seeing eye of God

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Imagery of an all-seeing eye can be traced back to Egyptian mythology and the Eye of Horus.

Horus the Falcon God of the Sky – Egypt 5000 BC

The all seeing eye representing the eye of God keeping watch on humankind

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Christian icon of the Eye of Providence or the all seeing eye of God

A 1525 Jacopo Pontormo painting using the Eye of Providence in a triangle as a symbol of the Christian Trinity.

Ubiquitous

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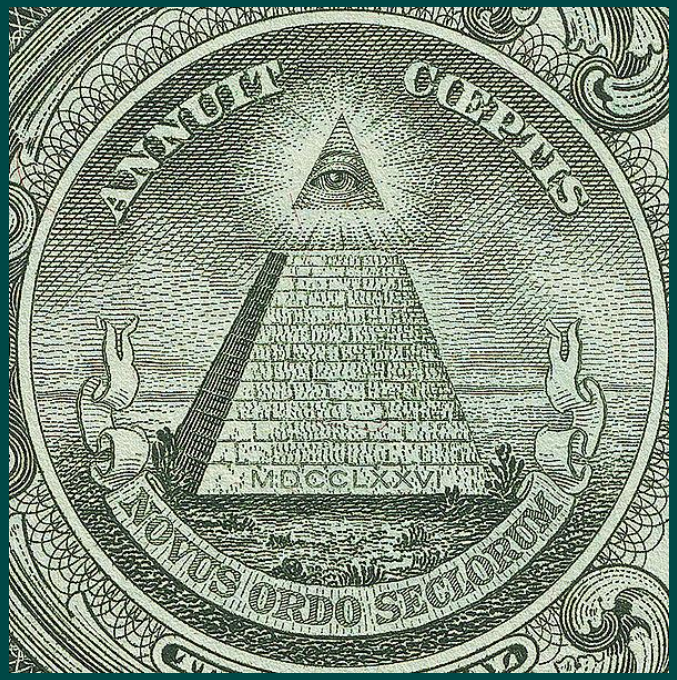

The Eye of Providence can be seen on the reverse of the Great Seal of the United States, seen here on the US $1 bill.

An all-seeing eye that appears on the tower of Aachen Cathedral

Jeremy Bentham's design for a 'panopticon' style prison.

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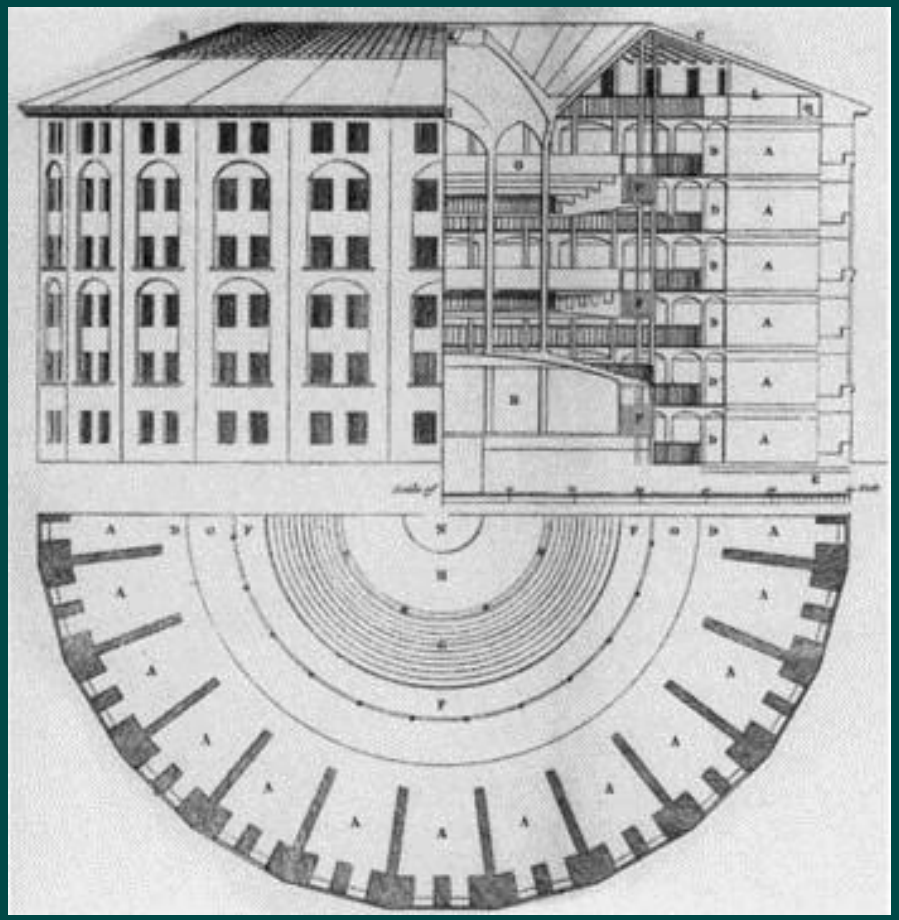

“Bentham laid down the principle that power should be visible and unverifiable.

Visible: the inmate will constantly have before his eyes the tall outline of the central tower from which he is spied upon.

Unverifiable: the inmate must never know whether he is being looked at at any one moment; but he must be sure that he may always be so. “

French philosopher Michel Foucault described the implications of 'Panopticism' in his 1975 work *Discipline & Punish: The Birth of the Prison* --

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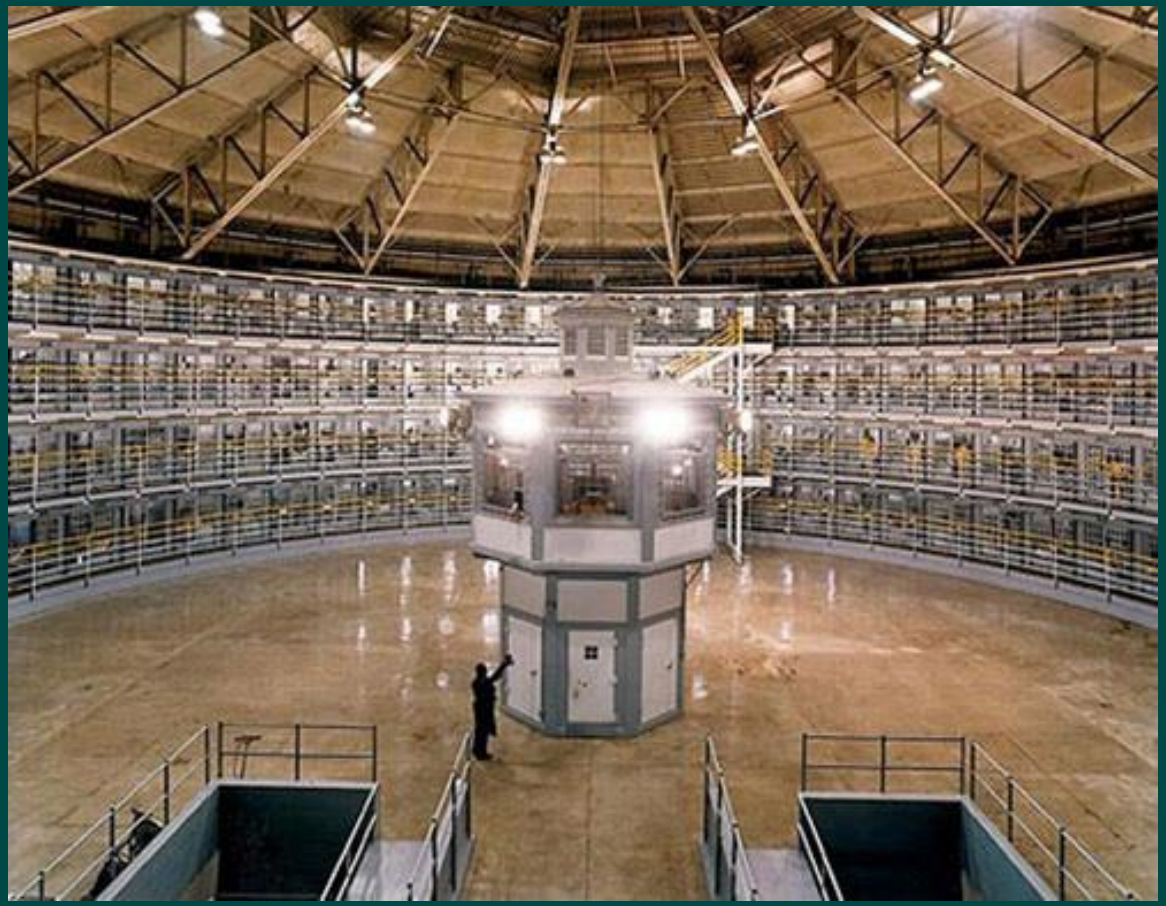

“Hence the major effect of the Panopticon:

to induce in the inmate a state of conscious and permanent visibility that assures the automatic functioning of power.

So to arrange things so that the surveillance is permanent in its effects, even if it is discontinuous in its action;

that the perfection of power should tend to render its actual exercise unnecessary

Global Postioning System – a fundamental element of the Panopticon

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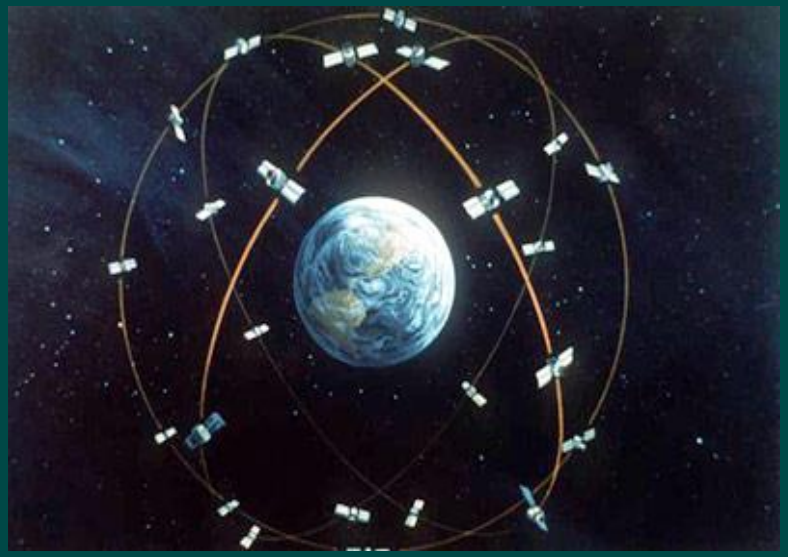

24 spacecraft in 12 hour circular orbits, with 3 on-orbit spares. Six circular orbital planes, R=26,560km

GPS User: Horseback Biologist in Amazon

What or Where is the Modern All Seeing Eye?

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Scientia est Potentia, Latin for Knowledge is Power

NASA Satellites

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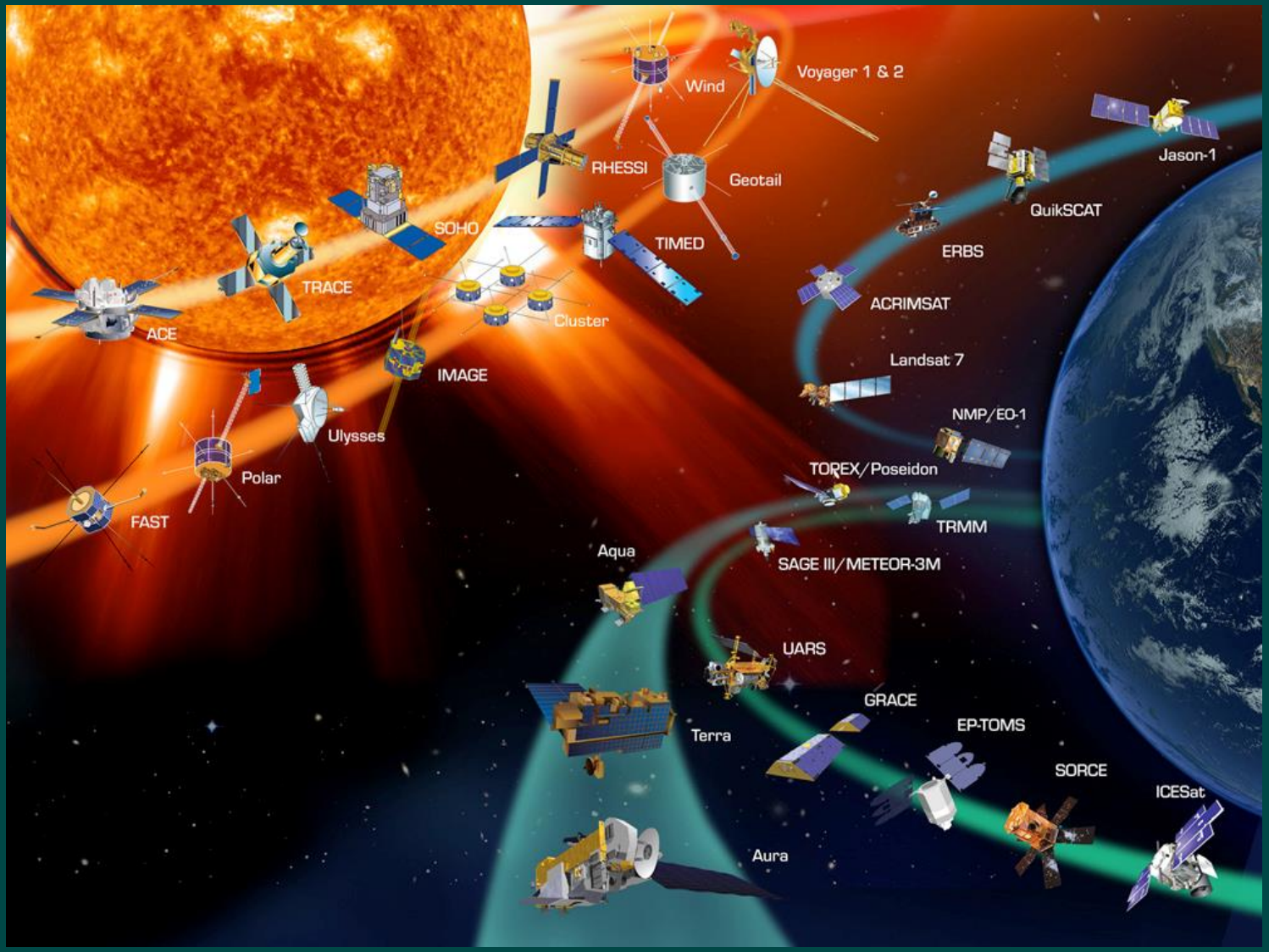

Space Surveillance Network

Worldwide Network of 20 Optical and Radar (Mechanical & Phased Array) Sensor Sites

Ground-*Based* Electro-Optical Deep *Space* Surveillance (GEODSS) - Diego Garcia / Maui / Socorro

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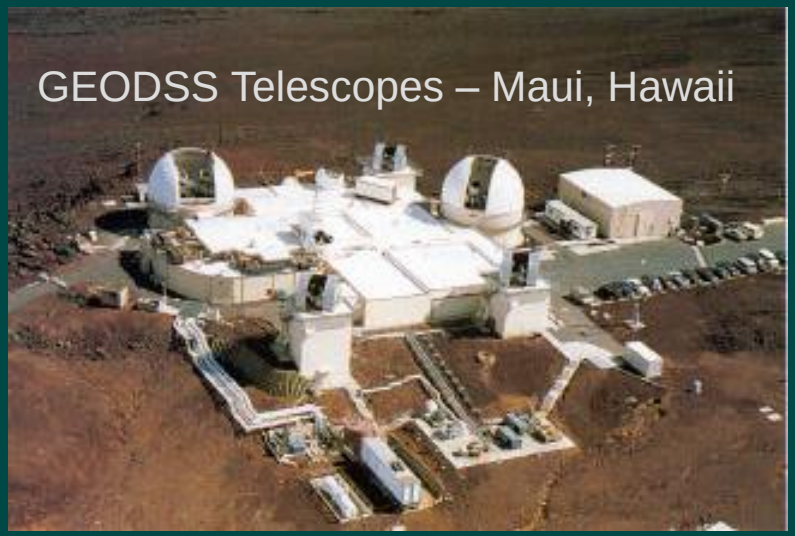
- Primary Mission: Space Surveillance
- Supports Air Force Space Command (AFSPC) as a dedicated Deep Space (DS) sensor
- GEODSS brings together the telescope, low-light-level cameras, and computers



Space Surveillance

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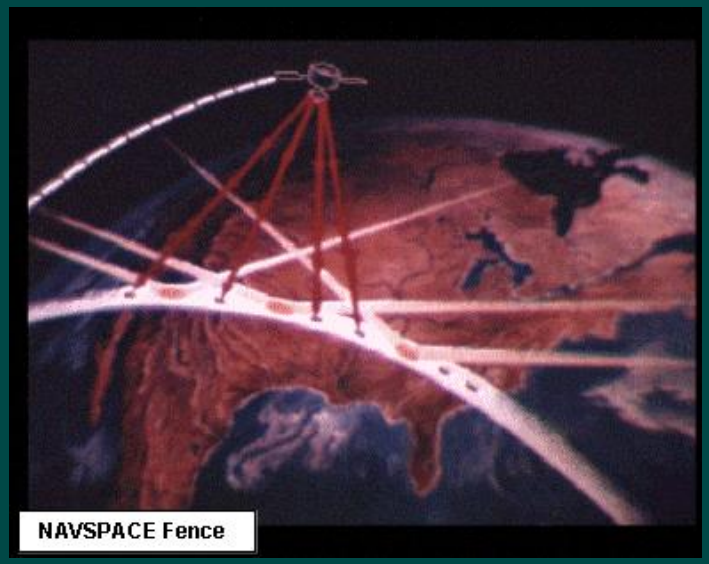
- Conduct space surveillance from space
- Surveillance of entire geosynchronous belt
- Assured access to objects of military interest



NAVSPACE Fence

- Provides up to date satellite orbital elements to Fleet and Fleet Marine forces
- Supports US Space Command as part of nation's worldwide Space Surveillance Network

Ubiquitous Sonar Surveillance Systems

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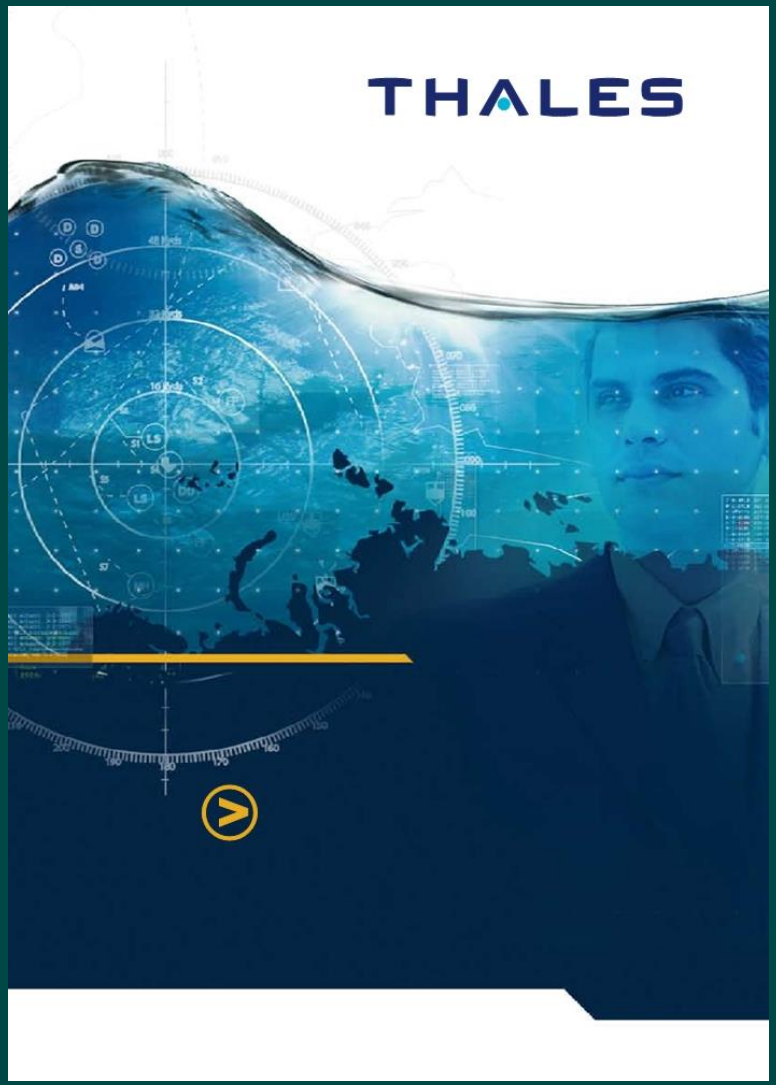

Satellite Image of Military Vehicles

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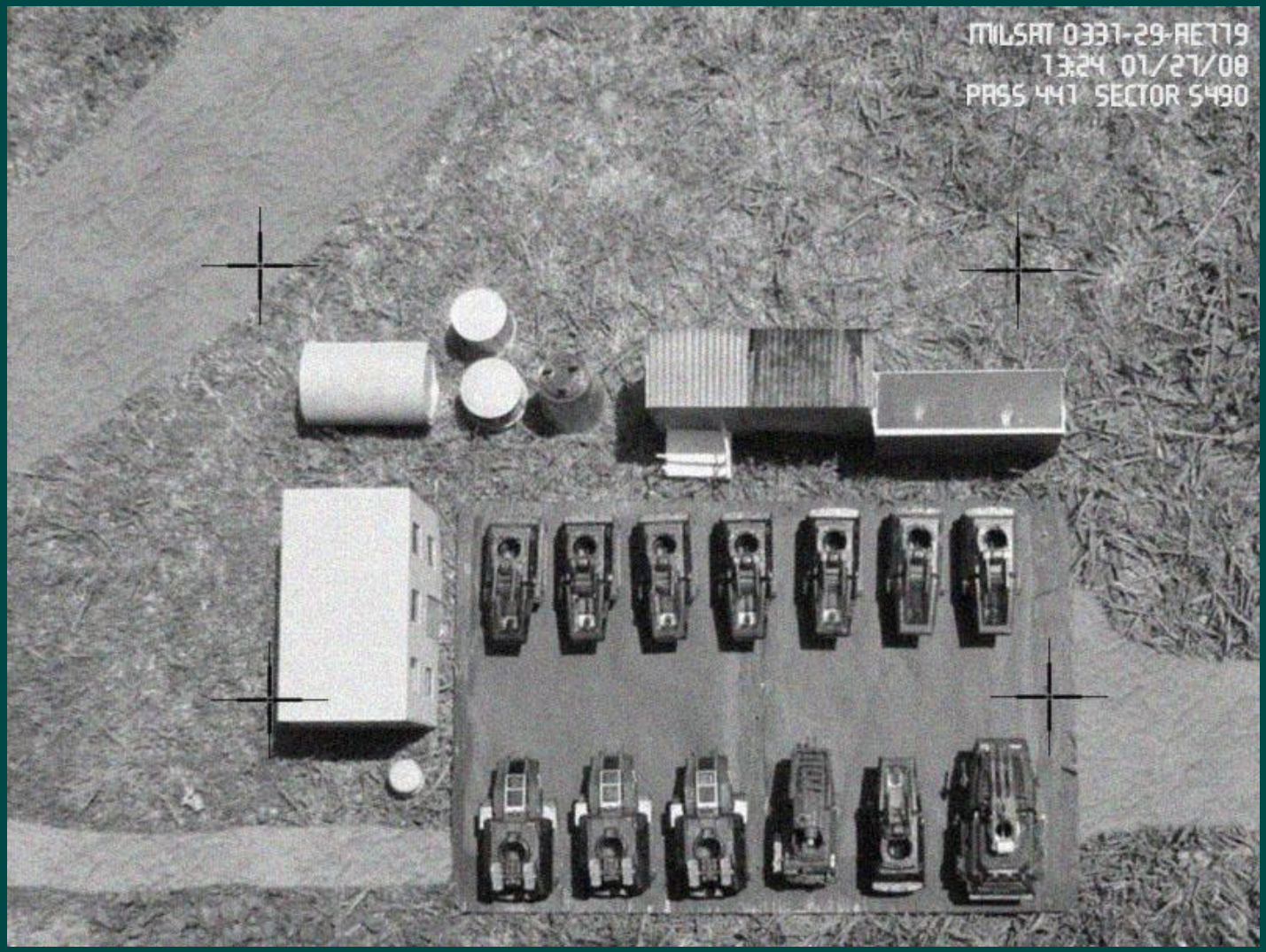

Pentagon Repairs

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One-meter resolution satellite image of the Pentagon reconstruction progress was collected on Nov. 20, 2001 by Space Imaging's IKONOS satellite. An interior section of the Pentagon has been removed so that reconstruction can proceed

Some Sonar Systems

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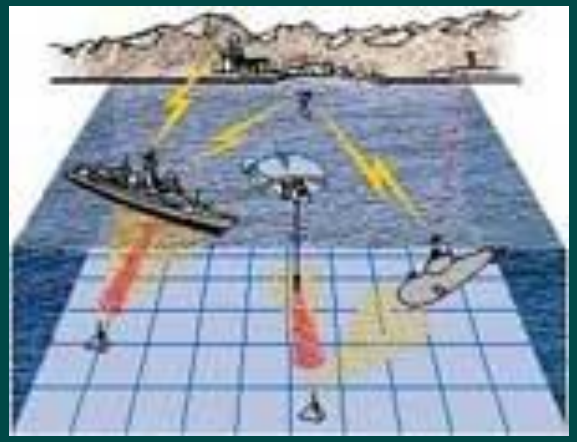

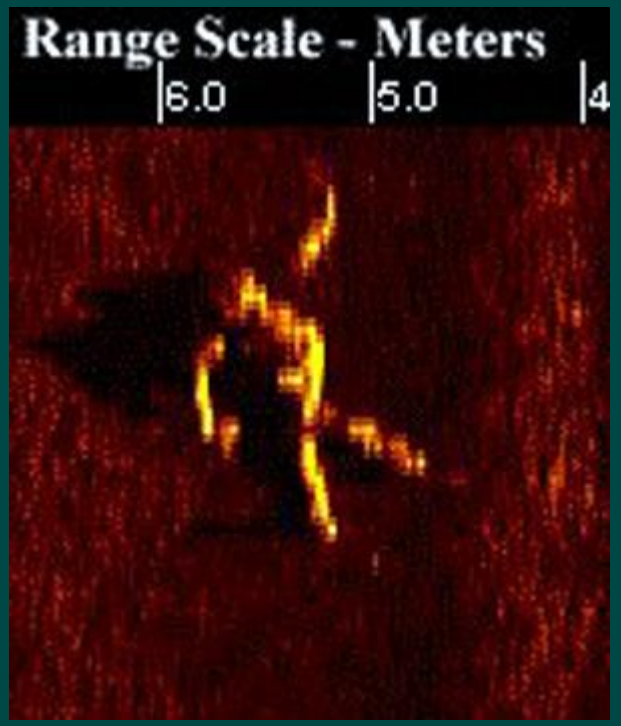

MST’s sonar systems are able to accurately identify small submerged objects such as discarded evidence or corpses, making it ideal for law enforcement investigations

Sonar Systems

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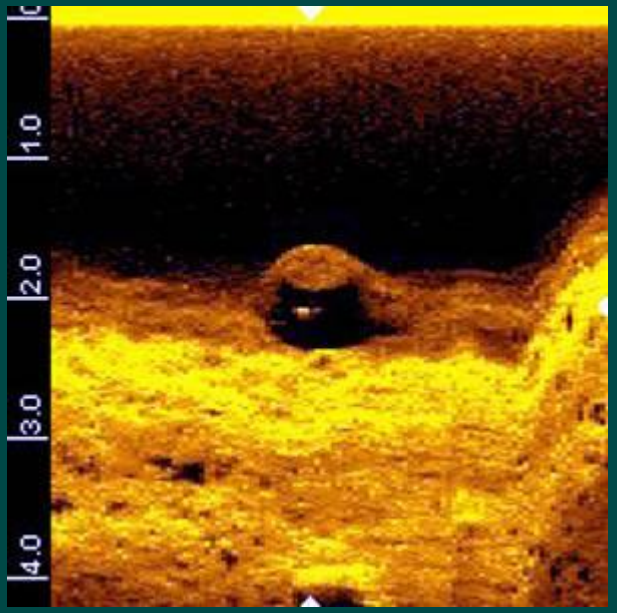
Thales CAPTAS - Combined Active / Passive Towed Array Sonar - is a family of low frequency variable depth ASW sonars for surface ships



MST's sonar detection systems can accurately image small underwater threats such as mines.

Satellite Communication Systems Integrate into the Global Fibre Backbone

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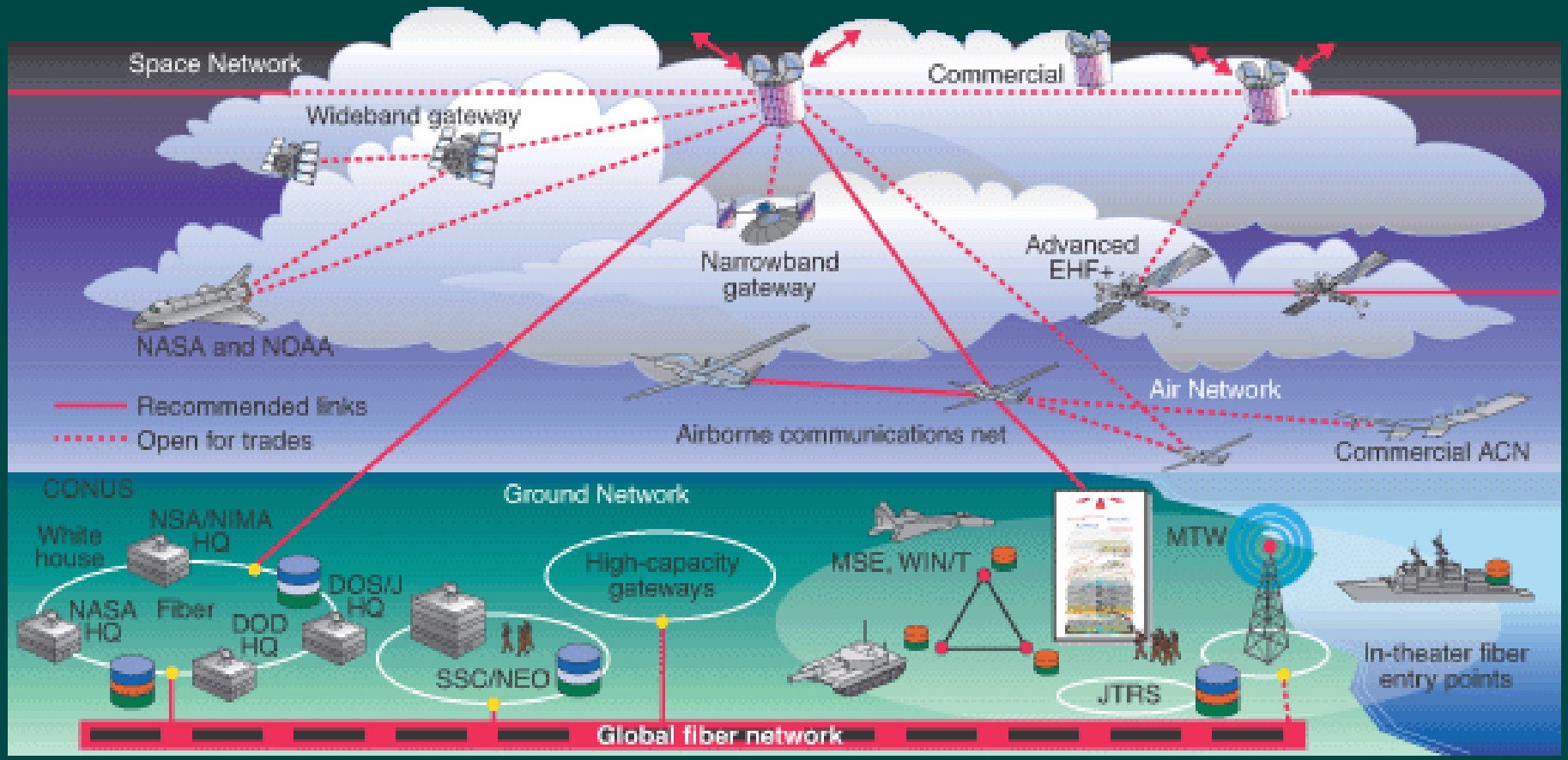

As Important as the Wheel

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Dr Charles Kao di STL, ora Nortel

A graduate of Woolwich Polytechnic won the Nobel Prize for Physics yesterday. Charles Kuen Kao's work with fibre optics paved the way for lightning-fast broadband.
Professor Kao was honoured for his breakthroughs involving the transmission of light in fibre optics.

He was the first person to develop efficient fibre-optic cables and as a result of his work more than a billion kilometres of optical cables carry super-fast broadband internet data to and from households and offices around the world.

DWDM Optical Fibre Communications
- Capacity: 7.1 terabytes per second Dec 2007
Fundamental element of Panopticon

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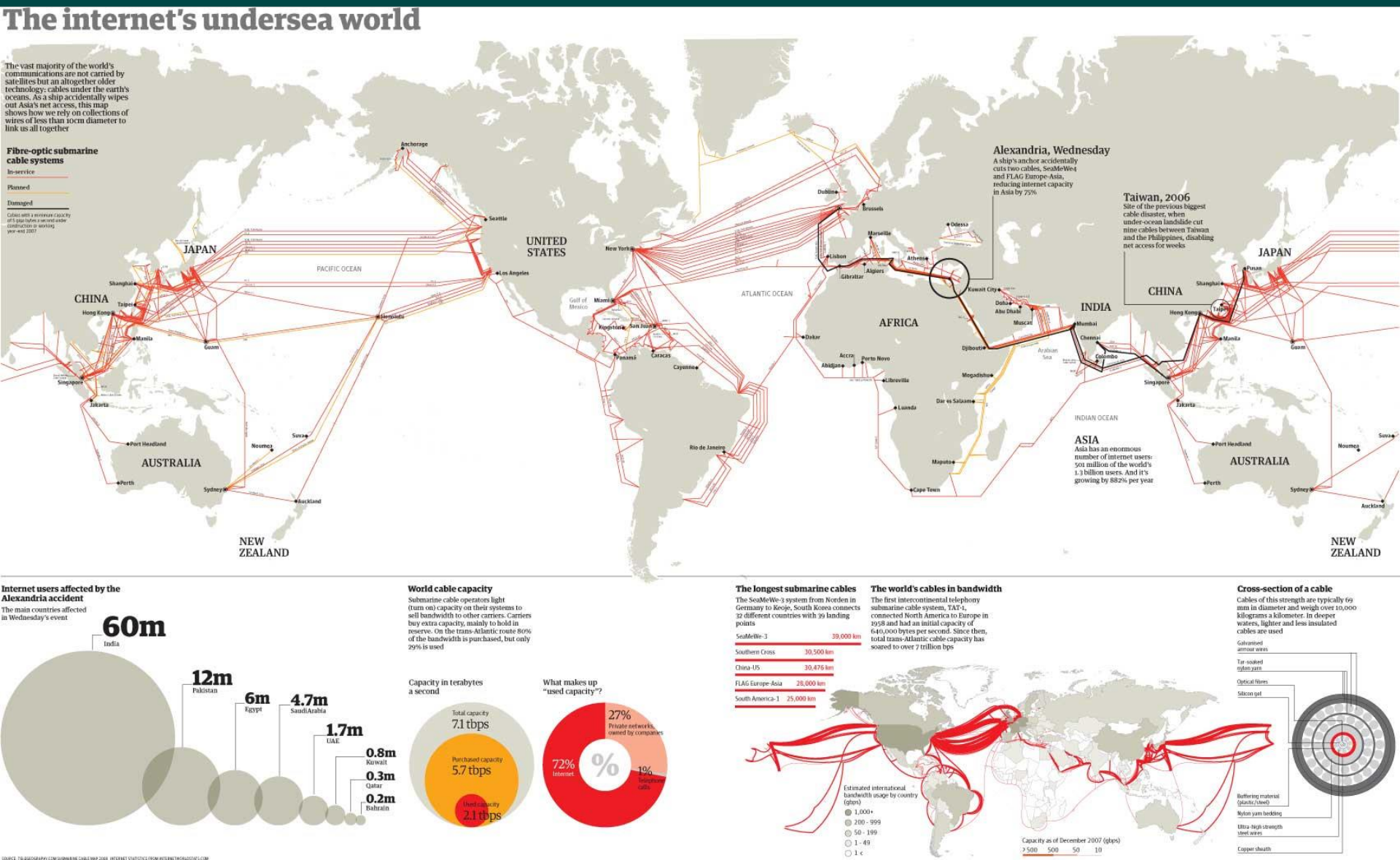

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GCHQ

GCHQ's headquarters are in Cheltenham, Gloucestershire. There are two much smaller sites in Cornwall and Yorkshire but most of the 5500 staff work at the impressive state of the art building at Benhall in Cheltenham.

Trans-Atlantic Fibre Optic Cables

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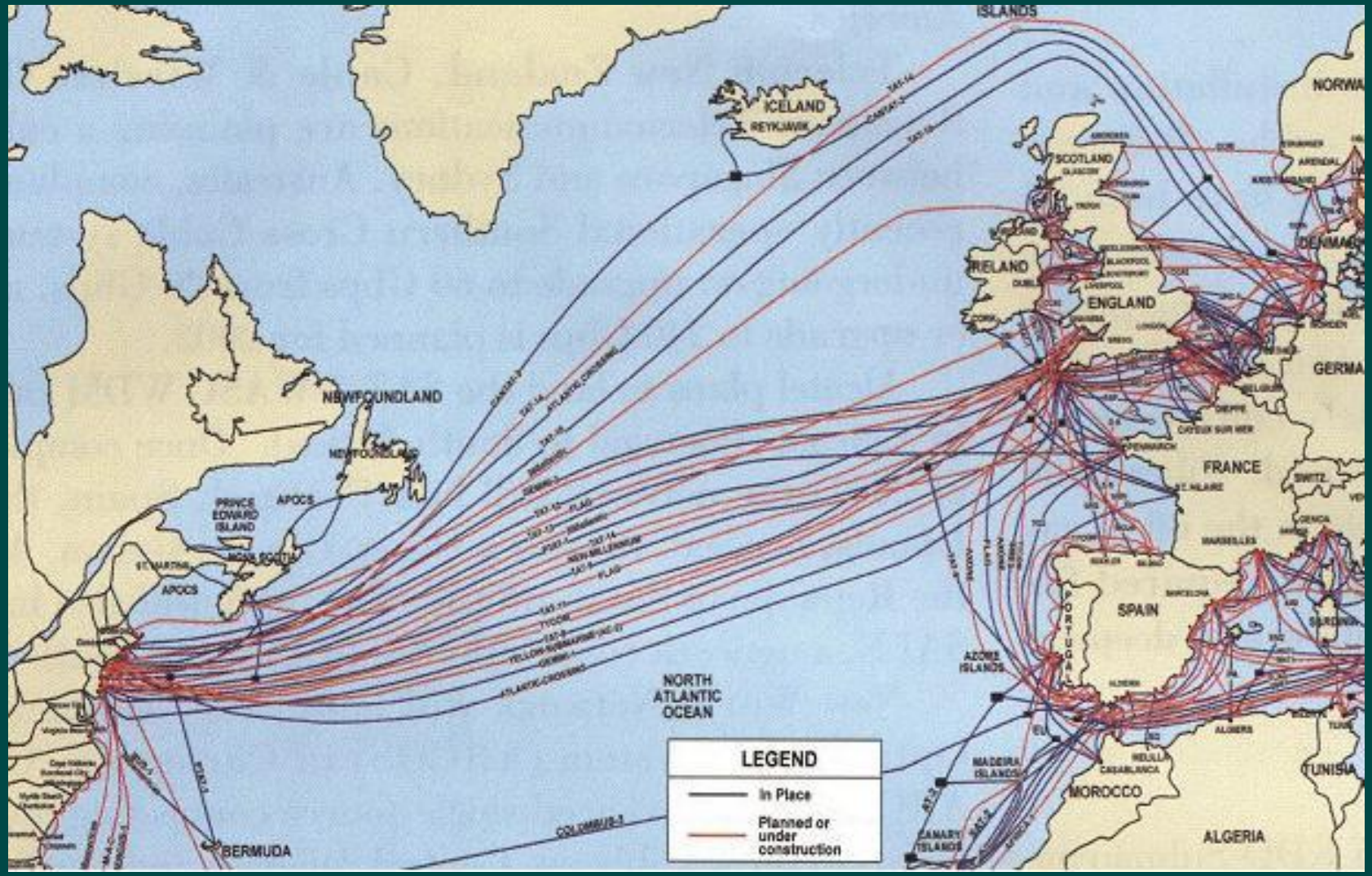

Cisco Catalyst 6500 Series Switches/Routers - Fundamental Technology for Panopticon

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Evolution of All Optical Communication Network

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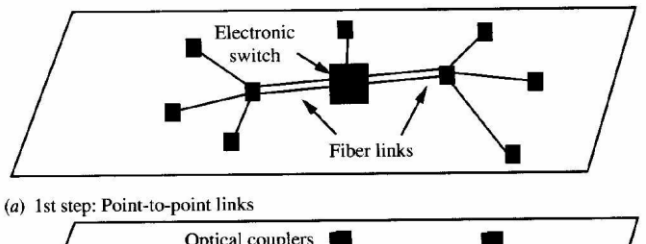
a) Point to Point Links

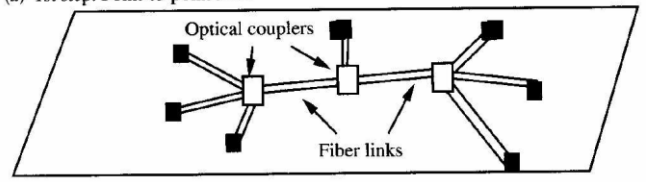
b) Optical domain multiplexing

c) Photonic switching

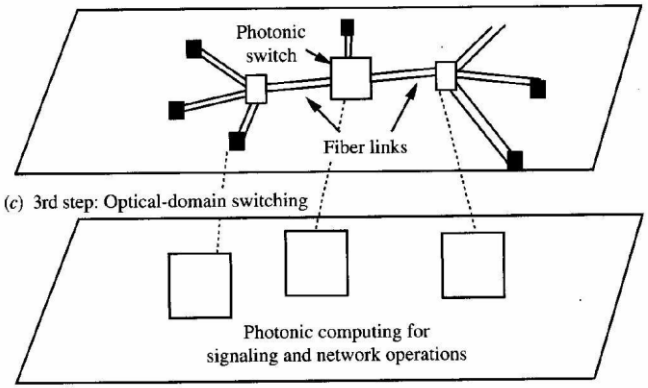
d) Photonic computing



(*a*) 1st step: Point-to-point links



(*b*) 2nd step: Optical-domain multiplexing



(*c*) 3rd step: Optical-domain switching

(*d*) 4th step: Photonic computing

4 x 4 electro-optic photonic switch

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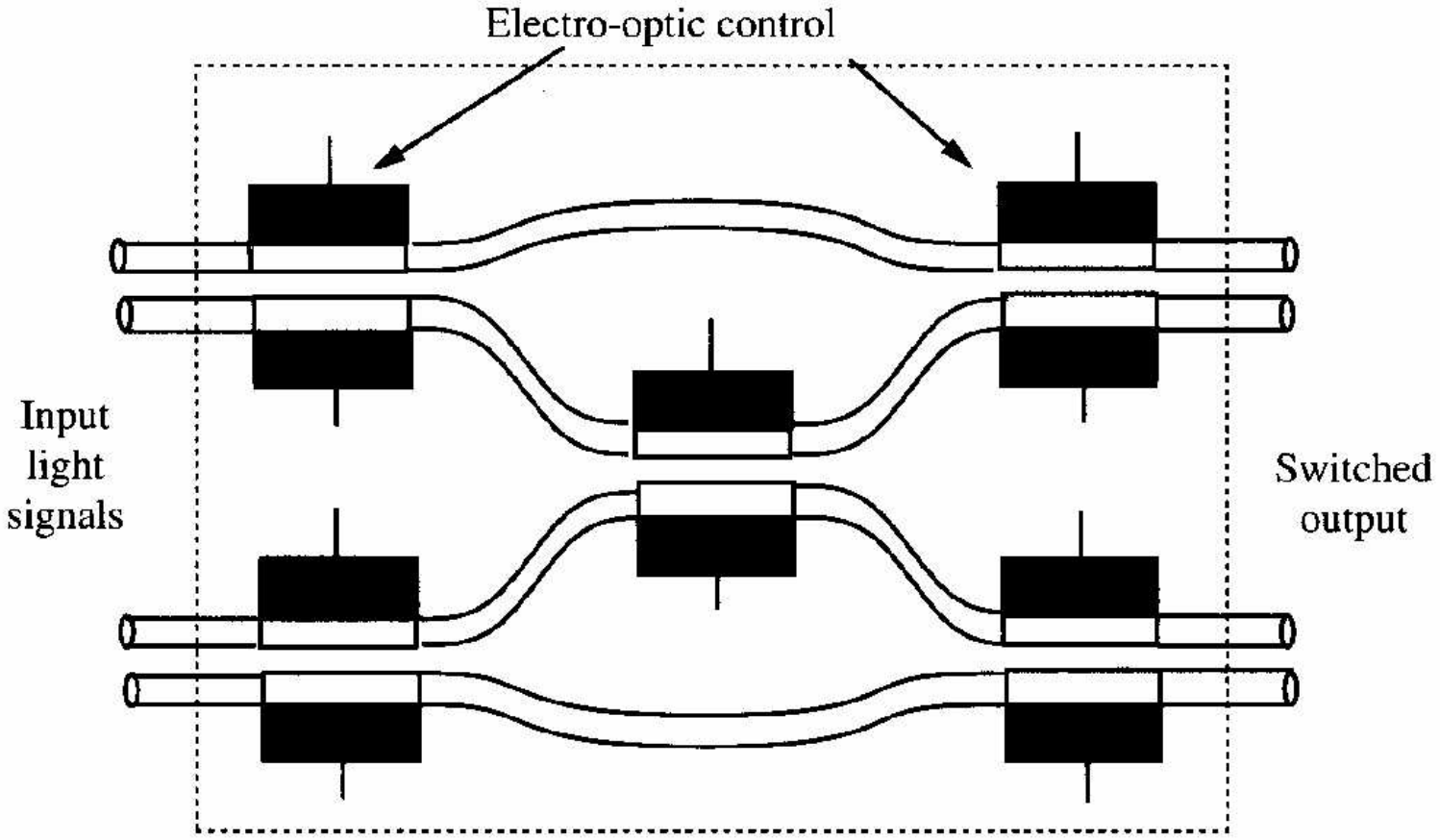
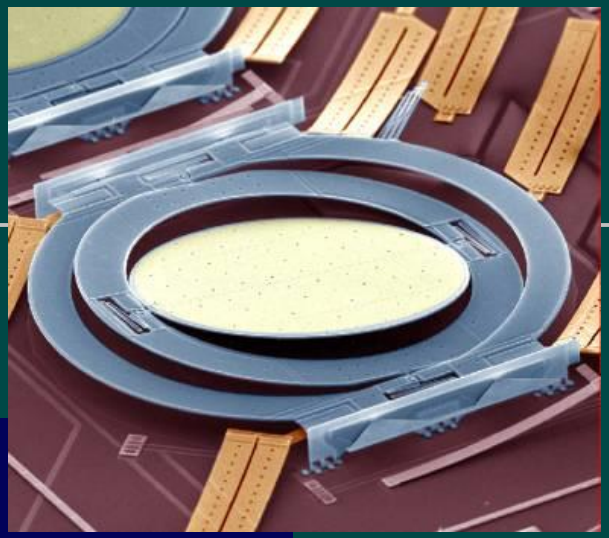
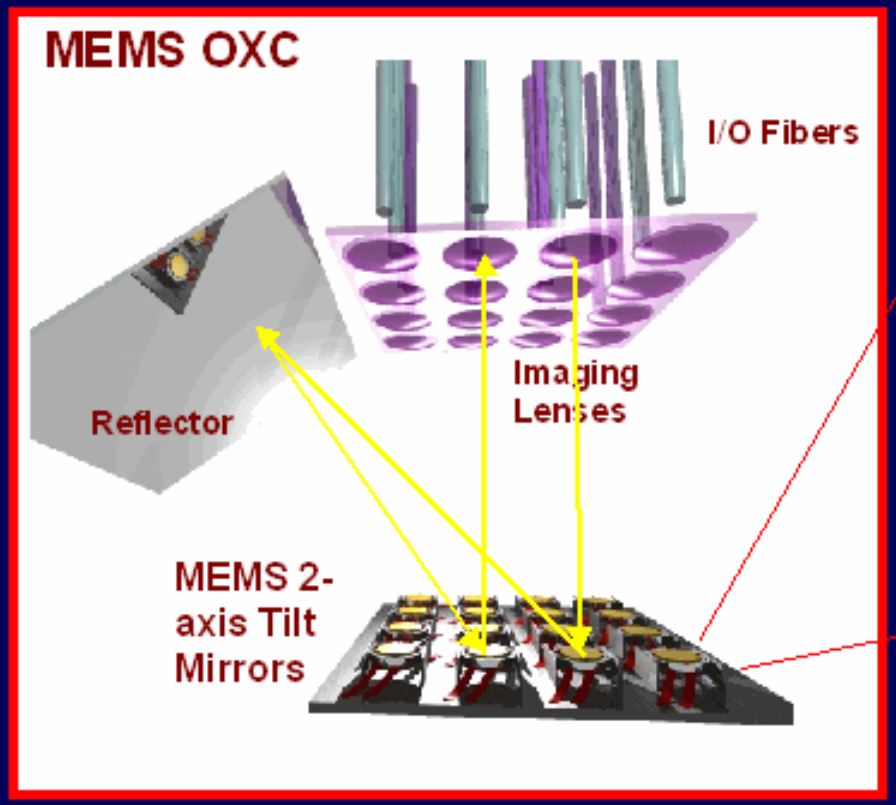


MEMS Mirrors



Lucent MEMS OXC



MEMS DEVICE:

- 2-axis, angular range of > ±6°
- continuous, controlled tilt
- directly scalable to 256 mirrors (1024 in the long term)
- simple technology for rapid development / prototyping
- manufacturable

Glimmerglass Intelligent Optical Switch

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System 500
32x32 - 190x190

Internet Peering Exchange via Optical Switching

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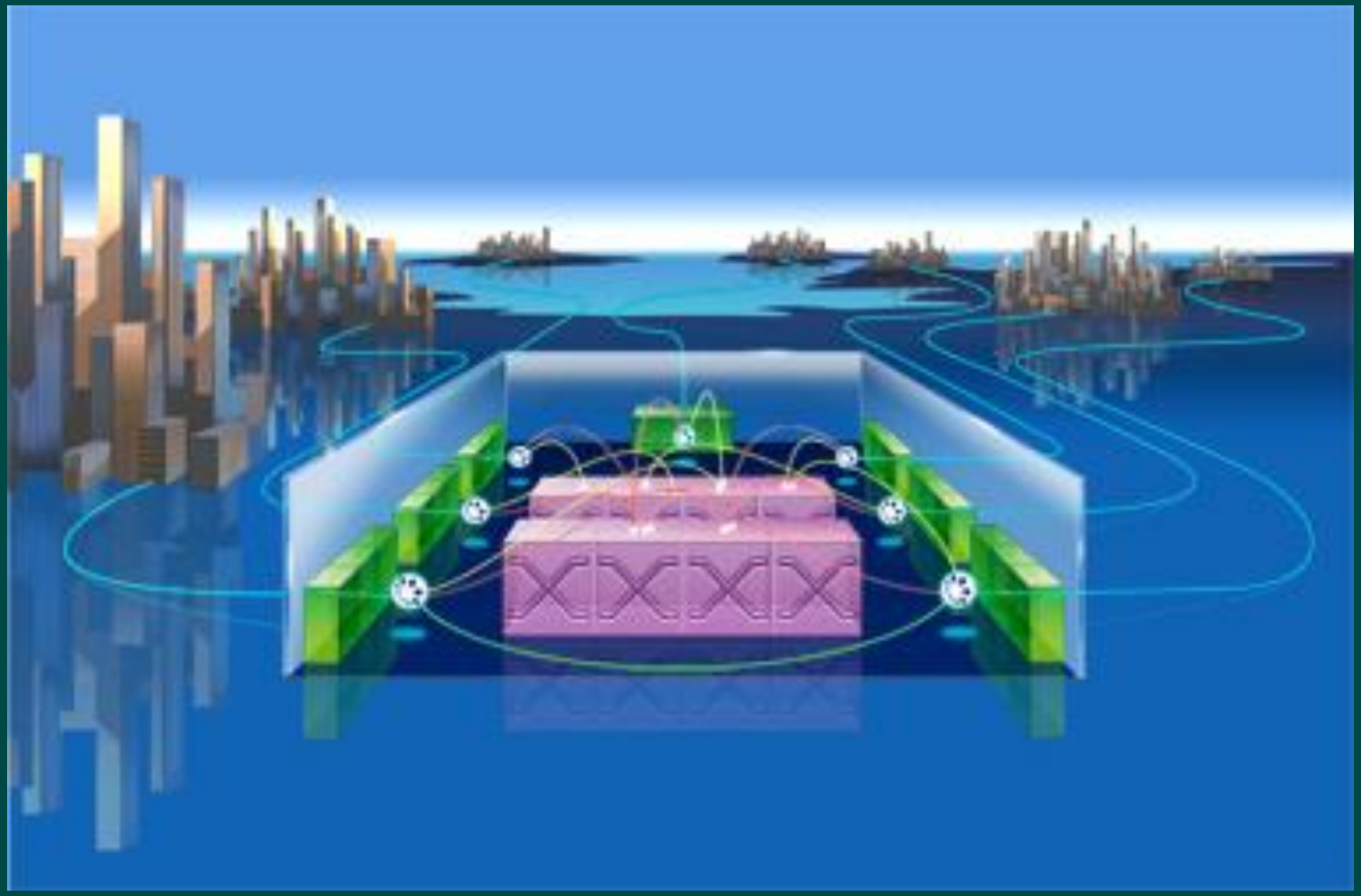

How much of the time are we being watched?

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- Much of the time there is no observer
- In the UK it is estimated that there are 4 million surveillance cameras
- Most of the data is not looked at as we have information overload
- There is a great deal of effort going into automating the observation process via event detection

Decision-support for the person in the loop

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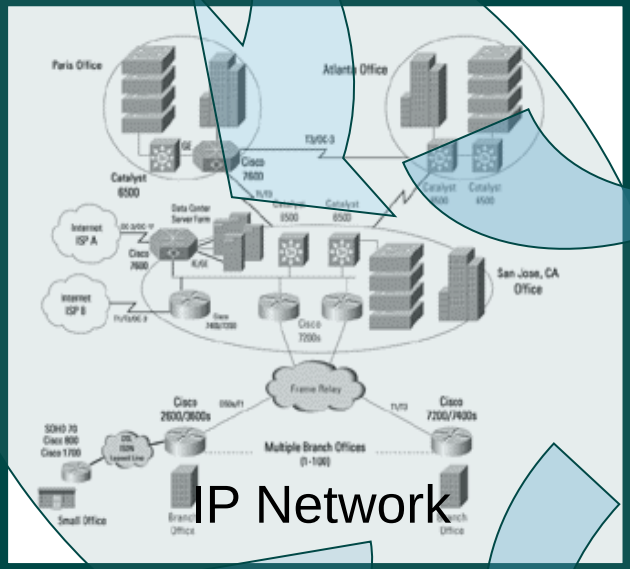
We are addressing the problem of information overload using smart cameras to present information for:

- Decision-support
- To facilitate human intervention
- Human quality assessment

Smart IP Cameras mapped into 3D space

Alerts & Meta Data

Control Room



IP Network

Data & Meta-Data Storage

Responders

Response

Smart Camera Alerts

IP Network

Smart Camera Alerts

New Geospatial 3D Command Control Interface

GUI

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Smart Camera Technologies will Generate Alerts & Meta-Data

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Tilera - TILE*Pro*64 Processor

Stretch S6000 DSP

Cradle Multi DSP – CT 3616

Tilera - TILE*Pro*64 Processor

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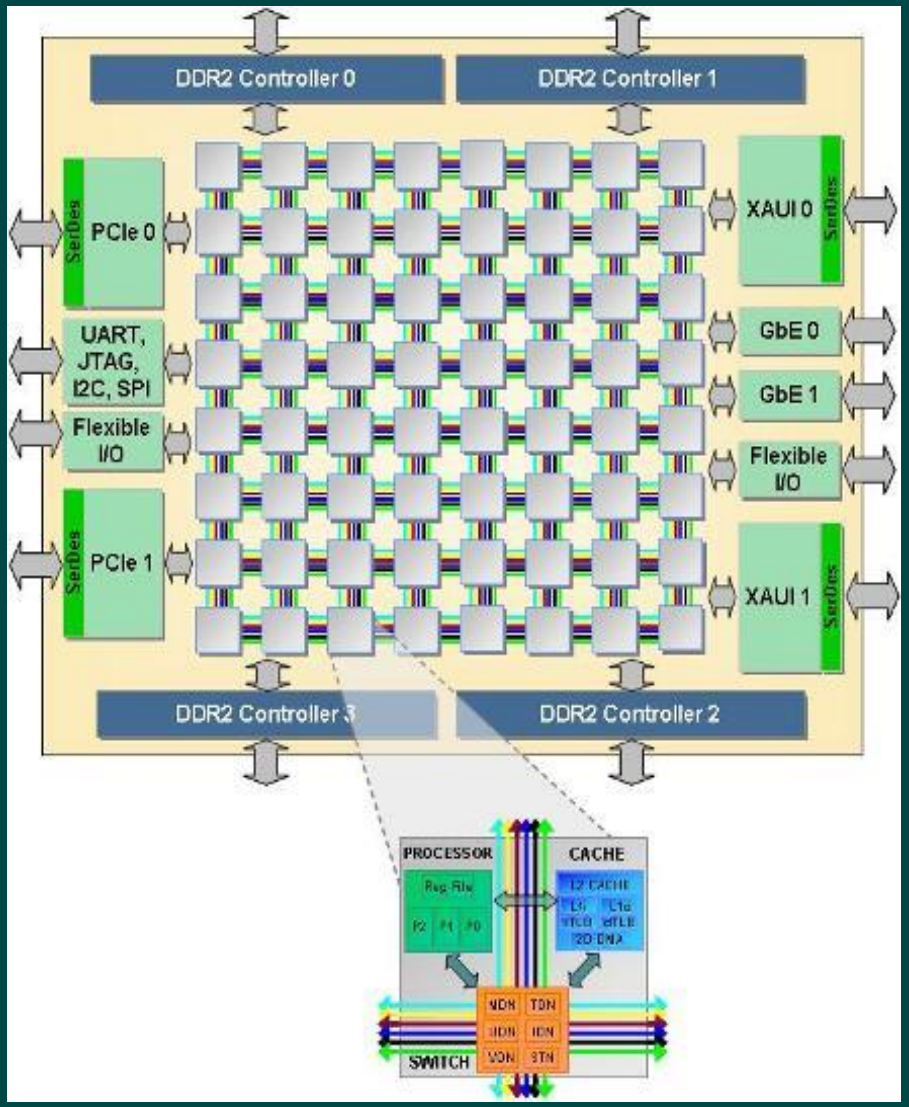

- *8 X 8 grid of identical, RISC processor cores (tiles) optimized for both signal processing and general purpose computing*
- *32-bit VLIW processors with 64-bit instruction bundle*
- *5.6 Mbytes of on-chip Cache*
- *Up to 443 billion operations per second (BOPS)*
- *37 Tbps of on-chip mesh interconnect*
- *Up to 50 Gbps of I/O bandwidth*
- **19 – 23W @ 700MHz all cores active**

Stretch S6000 DSP

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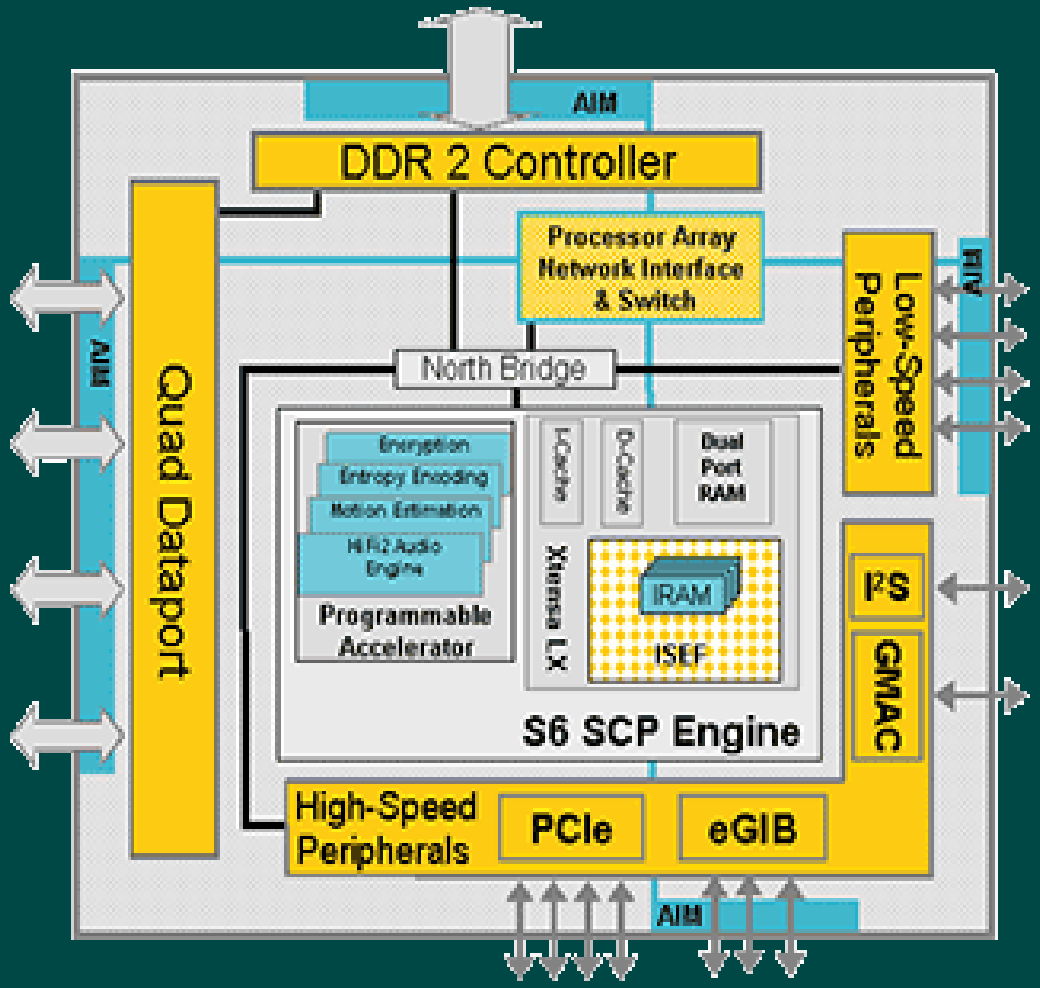

- Software Configurable Processor (SCP)
  - Xtensa LX VLIW Processor
  - 2nd Generation Programmable Compute Fabric – ISEF
  - 300MHz
- Processor Array
  - Dedicated Networking and Switching Hardware
  - Glueless Processor Interconnect - AIM
- Programmable Accelerator
  - Optimized Engines for Video and Security Processing
- Technology
  - TSMC 130nm LVOD
  - 27x27 BGA, 622 Balls
  - ~ 339 Signal Pin

Cradle Multi DSP

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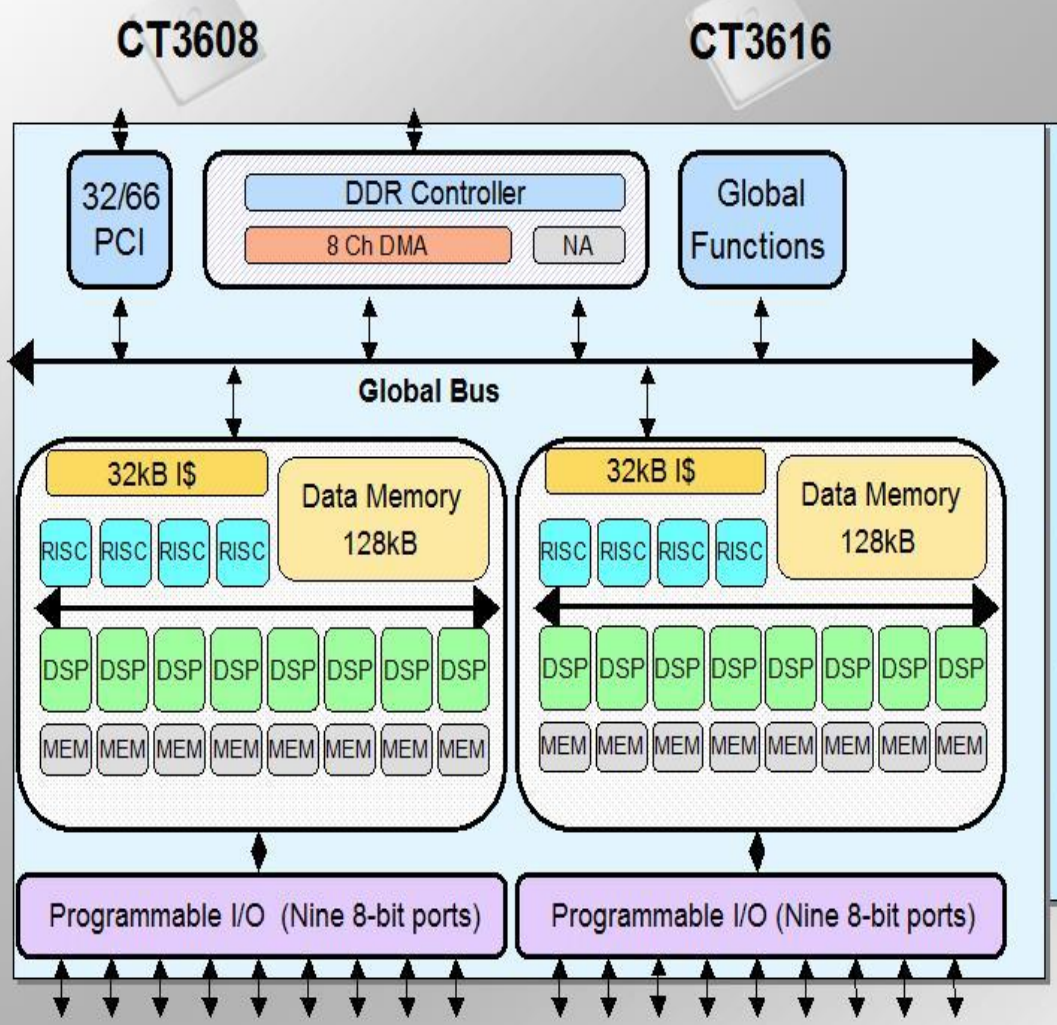

- CT3616: 8 RISCs + 16 DSPs Loosely Coupled
  - Multimedia apps, able to divide task, run parallel, multi-thread applications
- Integrated RISCs
  - Control/Data Flow
- Smart I/O
  - Eliminates I/F Chips
- 3-4 x Performance of Competitors

What are the Limitations of Existing Systems?

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- Today's interaction designed for point and click on individual items, groups (folders) and lists
- They assume the user knows the subject, concepts within information spaces, and can articulate what they want
- They assume data and interconnecting relationships are static in meaning over time
- They were designed 30 years ago

The New Paradigm

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- We are developing robust algorithms, which will comply with i-Lids specifications, that generate metadata derived from the image processing engine

- i-Lids scenarios
  - Sterile Zone
  - Parked Vehicle
  - Doorway Surveillance
  - Abandoned Baggage
  - Tracking

- We can provide a whole range of information from a smart camera to a control room

Meta Data

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– Location of event in the scene

– Time of event

– Object Velocity

– Object Size

– Object Colour

- Geo Co-ordinates

The New Paradigm

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- When this information is fused into a geospatial 3D command & control interface it is possible to perform a wide range of hitherto impossible tasks such as

- tracking individuals, cars etc in “real space”.

- Map the video into 3D space and be able to instantly see the geospatial context from the live video

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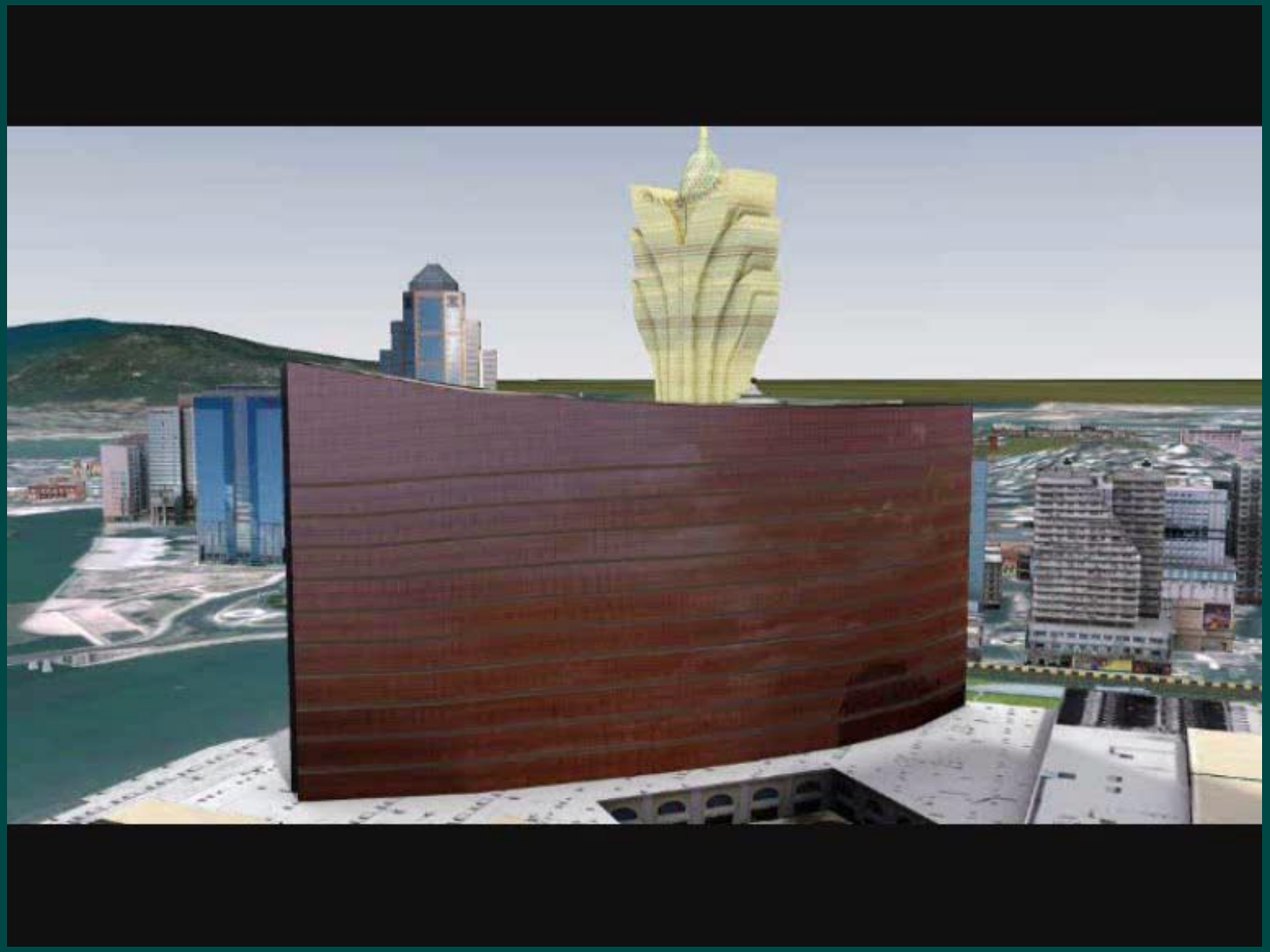

Integrate Data & Deploy Resources

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•Using multitouch technology and a new GUI, users will be able to rapidly set up and define the areas to be analysed, be it perimeter fence, doorway , area of road etc

• Perform rapid forensic searches against a whole range of criteria, such as blue car, moving down Cable Street between 12 and 1am on 14th August with a licence plate of.....

• To see all related video in the surrounding area at that time

• To locate and despatch rapidly the nearest resource to deal with the incident

• The system will allow wide scale collaboration on the same incident and scale data to many other screens

Imagine dozens of video/data streams from people, UAVs, and robot sensors distributed and moving through a scene…

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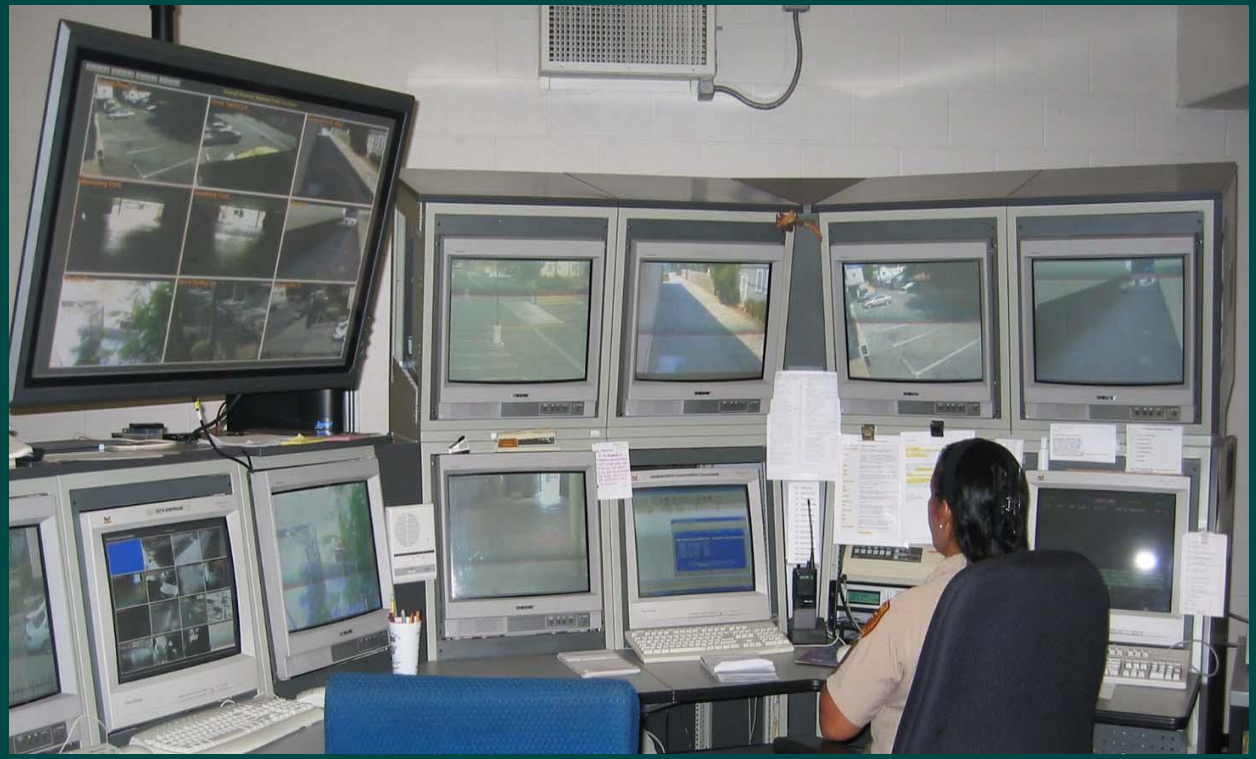
Problem: visualization as separate streams/images provides no integration of information, no high-level scene comprehension, and obstructs collaboration



Courtesy of 2020 Imaging

Many views, one 3D Picture

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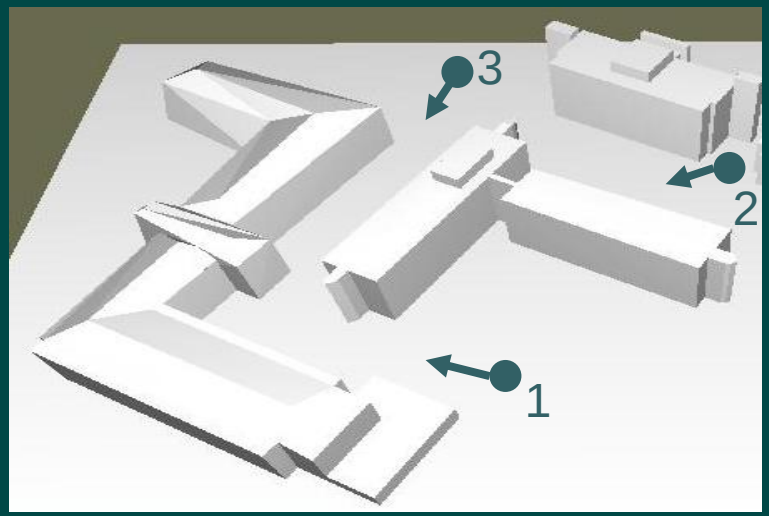

Courtesy of 2020 Imaging

The Old v The New

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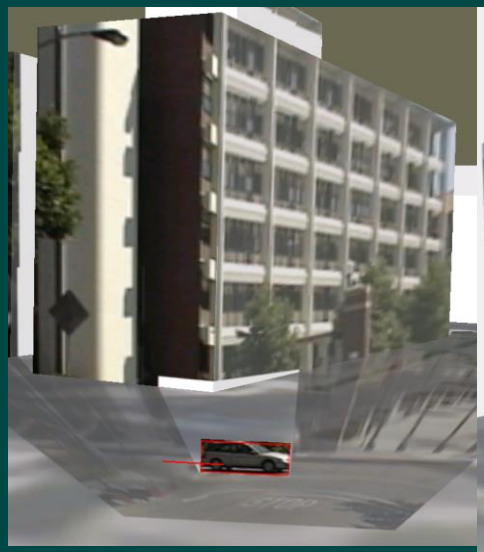
Current Surveillance Monitoring Center

- Overwhelmed with data fusion and comprehension of multiple image streams.
- Limited number of displays
- Waste of Resources

Better Surveillance System

- Better understanding of video streams
- Better use of resources
- Additional capabilities: tracking, statistics



Courtesy of 2020 Imaging

Augmented Video Environment

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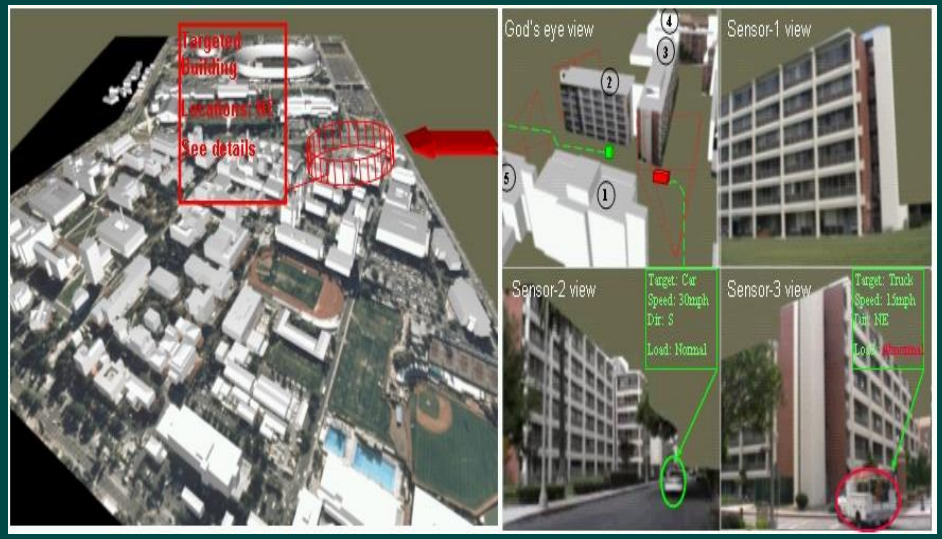
- ***VE**: captures only a snapshot of the real world, therefore lacks any representation of dynamic events and activities occurring in the scene*

- ***AVE** Approach*: uses sensor models and 3D models of the scene to integrate dynamic video/image data from different sources

- Visualize *all* data in a *single context* to maximize collaboration and comprehension of the big-picture

- Address dynamic visualization and change detection



Courtesy of 2020 Imaging

Tracking using live Video and 3D

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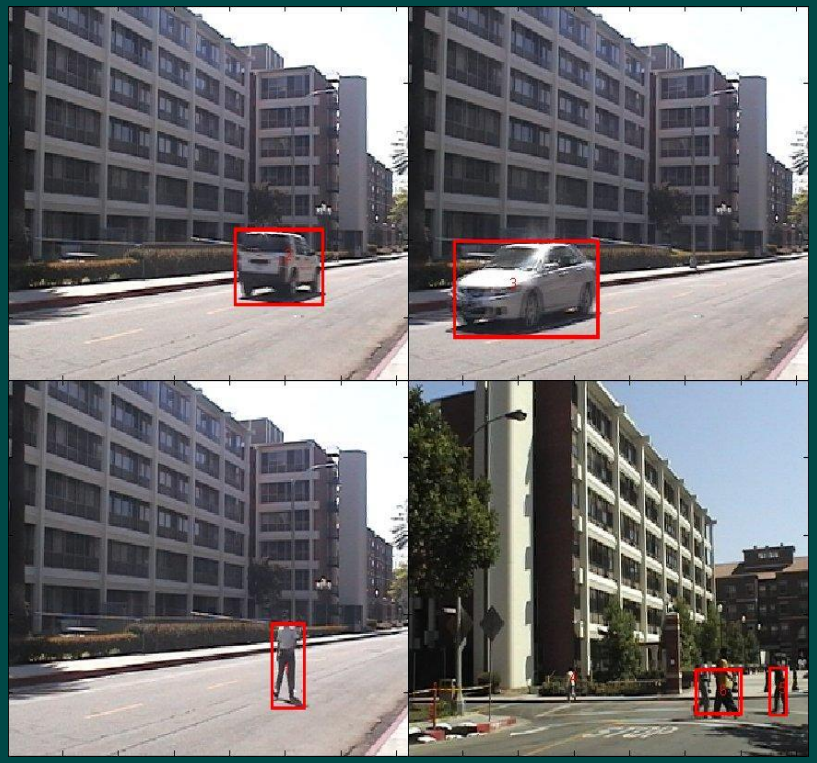
- Tracking in 2D and modeling in pseudo 3D



Courtesy of 2020 Imaging

Cameras Mapped into 3D Geo Space

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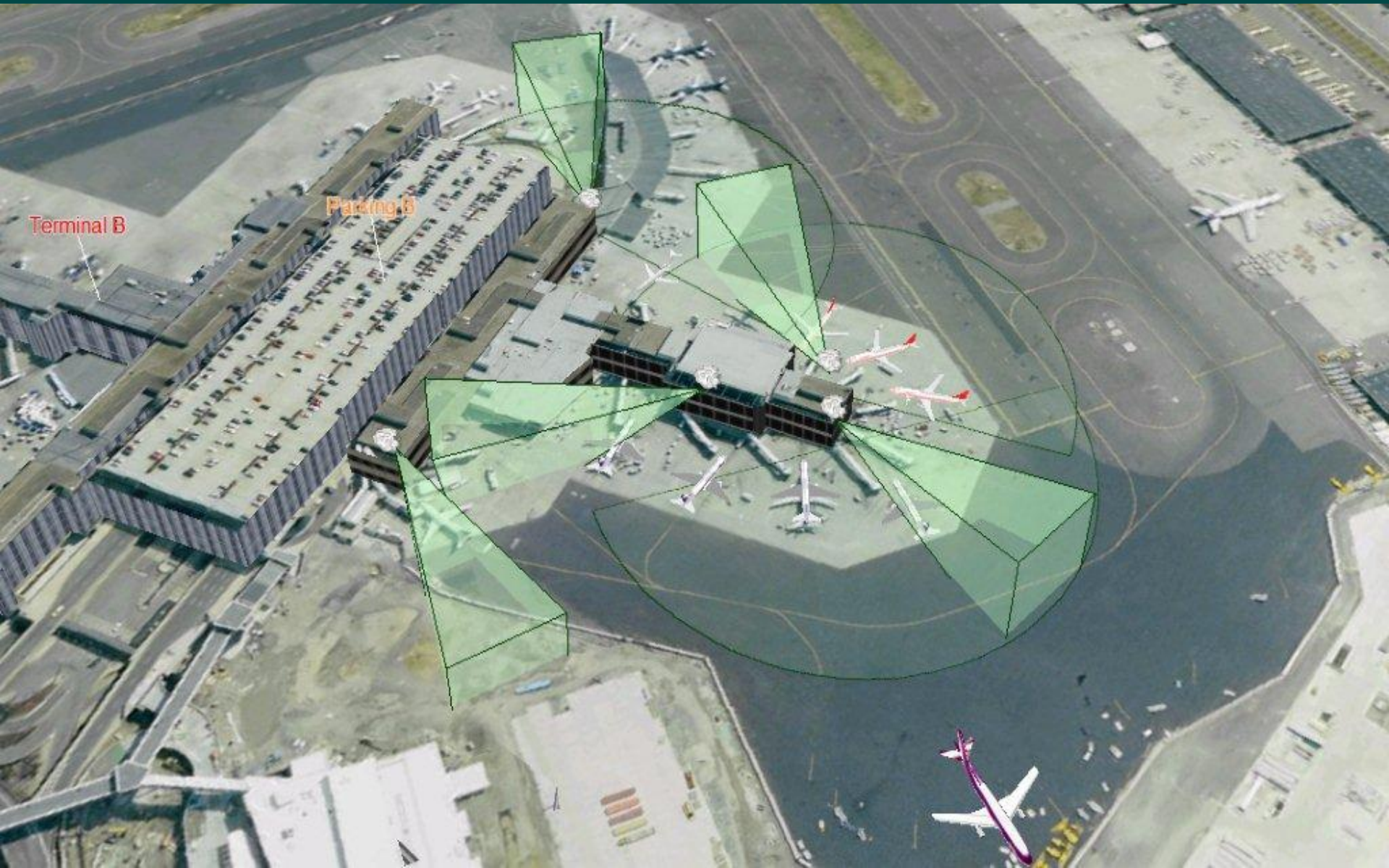

Biometric Performance

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Biometrics	Universality	Uniqueness	Permanence	Collectability	Performance	Acceptability	Circumvention
Face	H	L	M	H	L	H	L
Fingerprint	M	H	H	M	H	M	H
Hand Geometry	M	M	M	H	M	M	M
Keystroke Dynamics	L	L	L	M	L	M	M
Hand vein	M	M	M	M	M	M	H
Iris	H	H	H	M	H	L	H
Retina	H	H	M	L	H	L	H
Signature	L	L	L	H	L	H	L
Voice	M	L	L	M	L	H	L
Facial Thermogram	H	H	L	H	M	H	H
DNA	H	H	H	L	H	L	L

H=High, M=Medium, L=Low

Mobile Iris Biometric ID System

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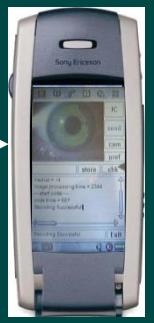
Locate Iris Image

Acquire Iris Image



Mobile Scanner

Transmit Iris Data

Convert Iris Data

Remote Database

Store Iris Data

Microchip

Datamatrix

Local Database

Acquire & Convert Iris Biometric into Data

Mobile Iris Biometric ID System

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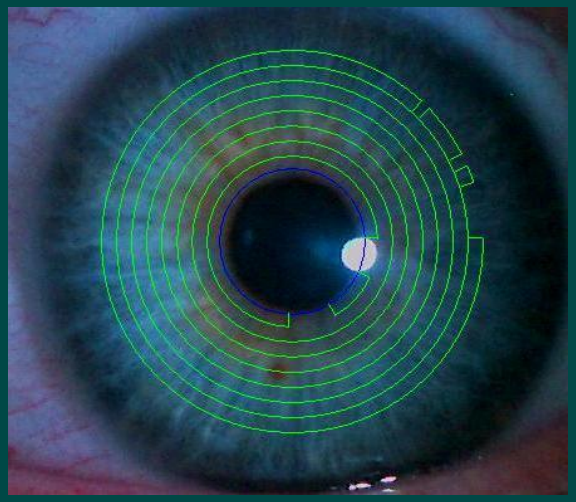
(a) Phone Screen Display

(b) Iris Captured for processing



(a) Screen display of successful Iris capture & processing less than 1 second.

(b) Captured image for processing with grid overlay

Mobile Iris Biometric ID System

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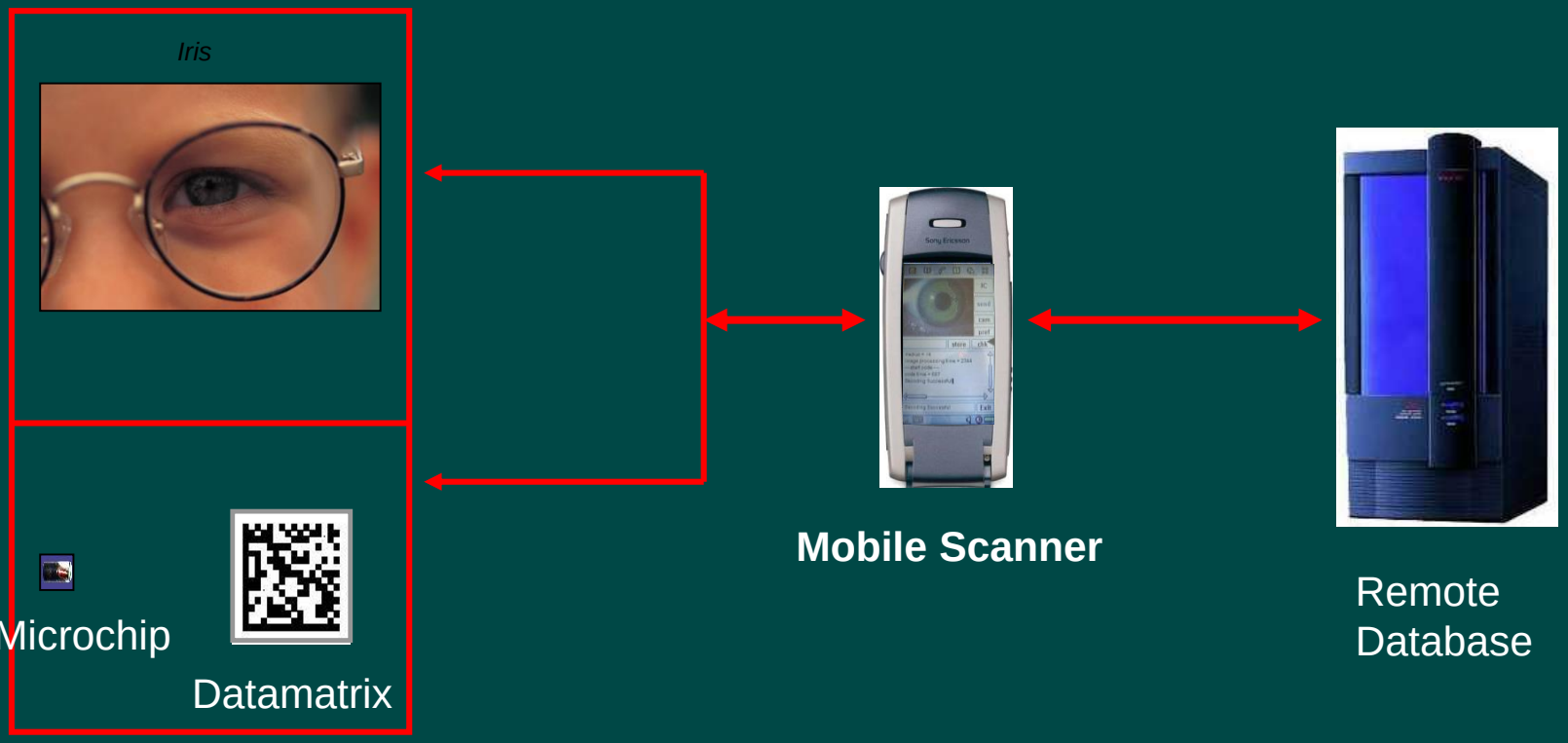

Scan to Compare Iris Biometric with Remote & Local Database (Iris/Microchip/Datamatrix)

Vein pattern recognition hardware

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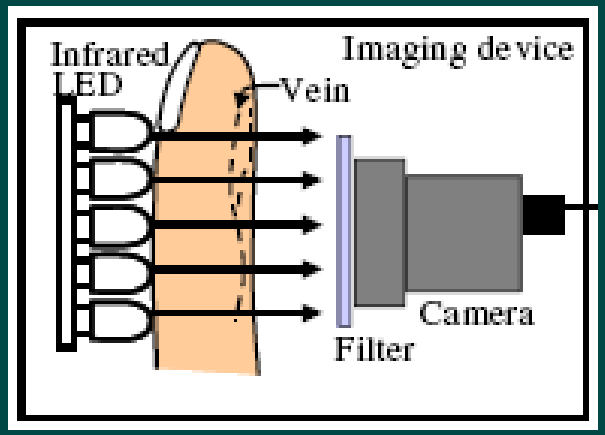
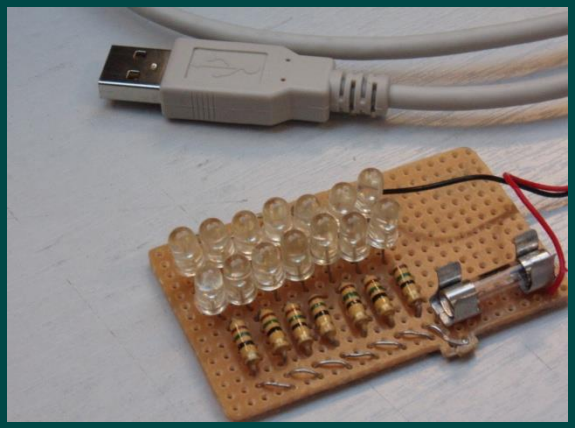
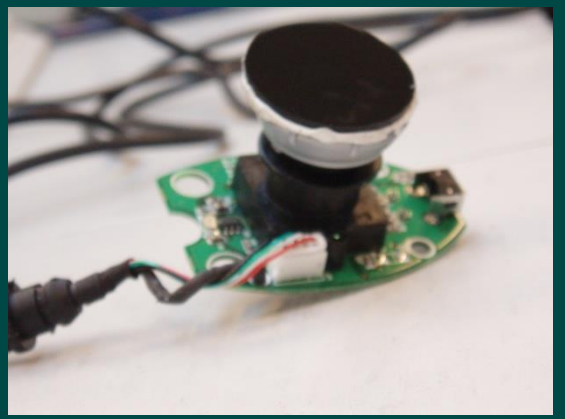


Finger placed on its dorsal side



14 Infrared LEDs with 810nm wavelength

USB powered (5V-500mA max)



CMOS webcam

Infrared (plastic) filter to cut-off visible light

Vein pattern image enhancement

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Image without using the infrared pass filter

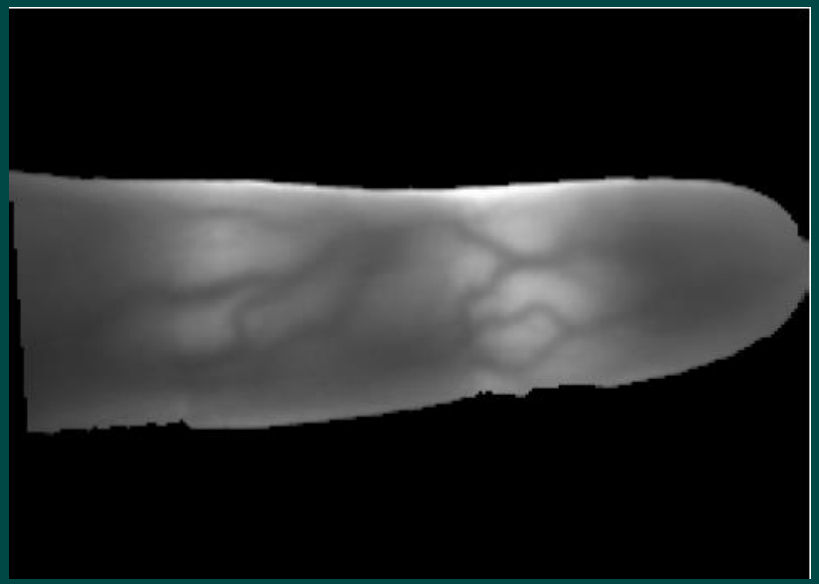

Image after using the pass filter

Multi–Biometric Data Fusion

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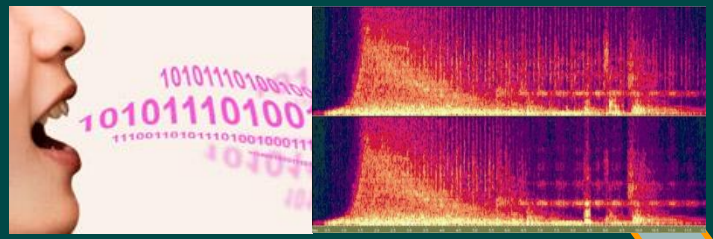
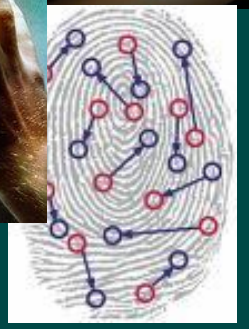
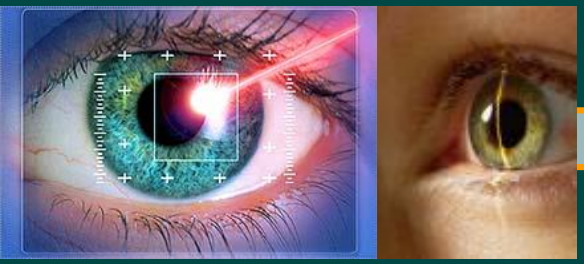
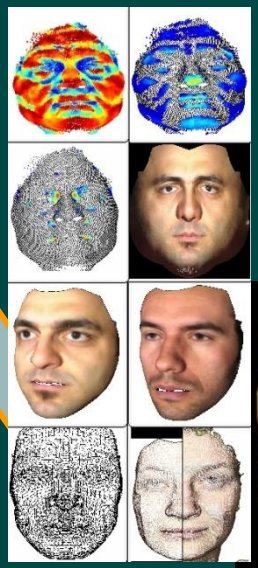
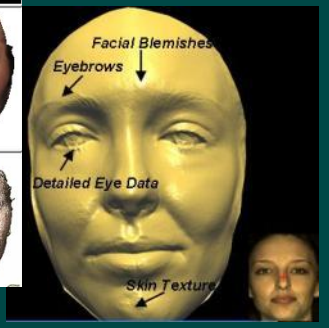


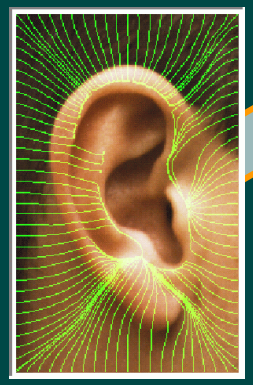


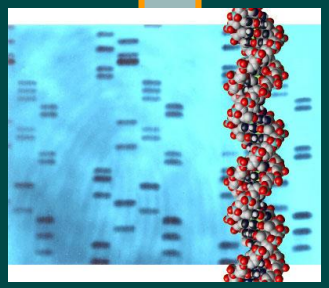


Biometric
Data Fusion









Biometric Applications

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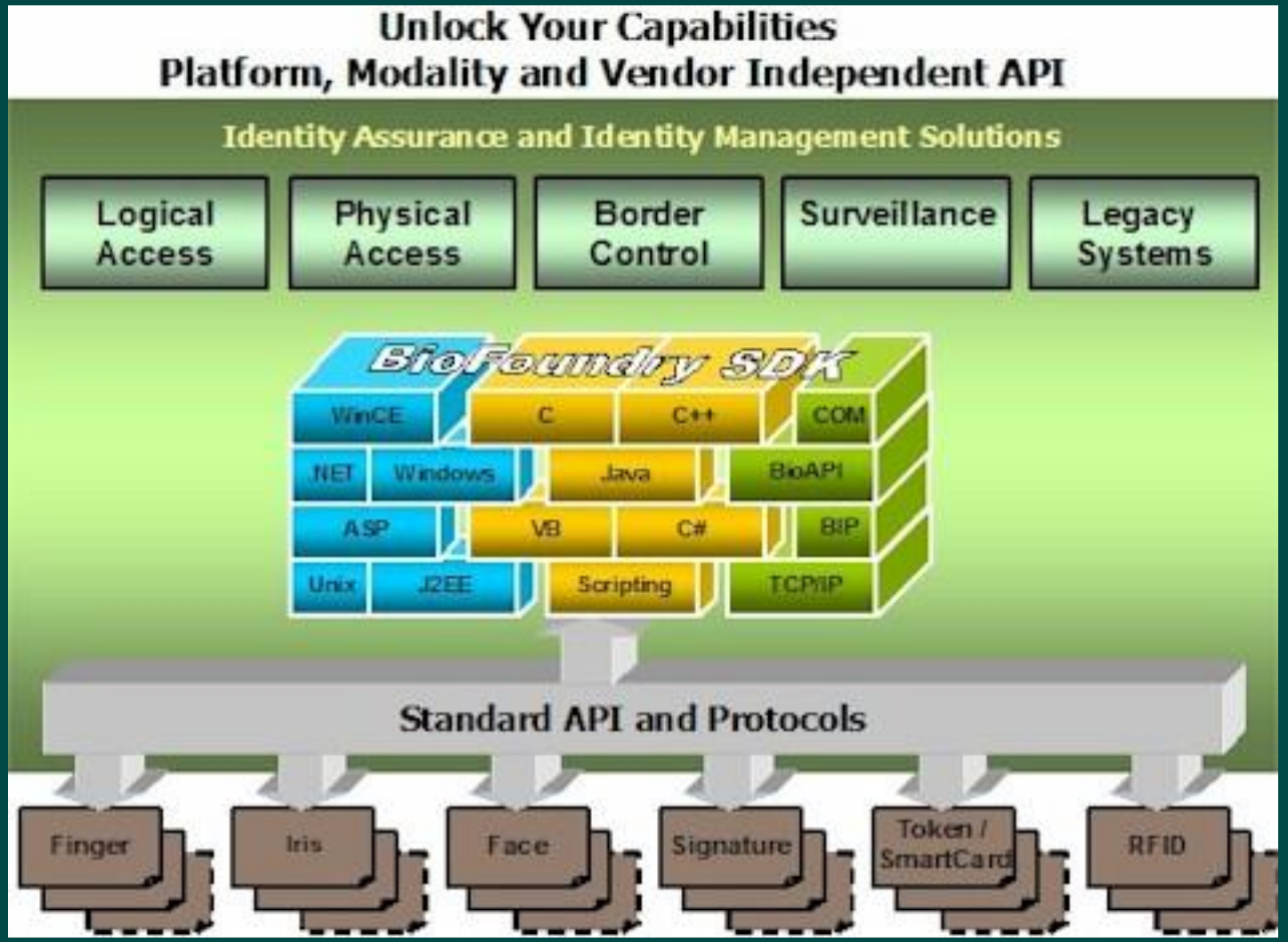

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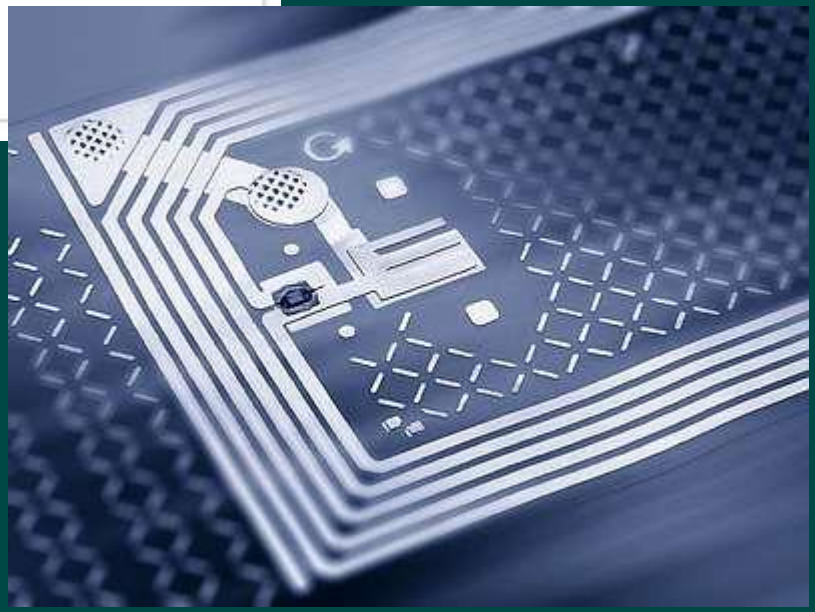
RFID



Untethered Trailer Tracking Wireless Terrestrial Communications

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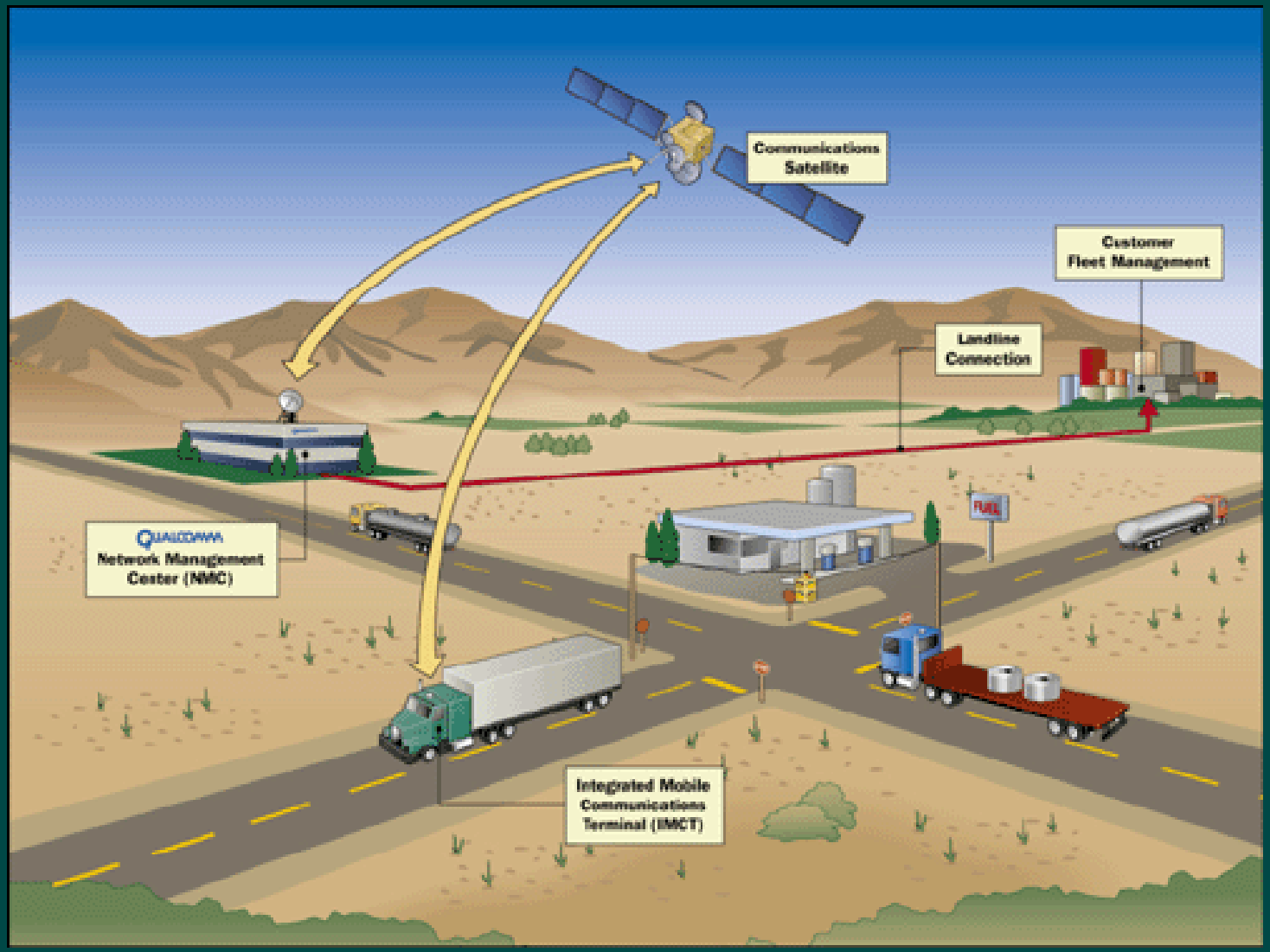

Track & Trace

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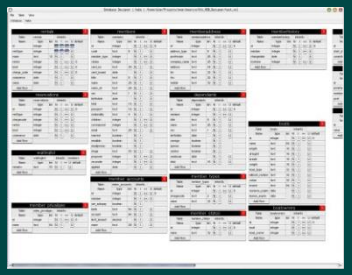
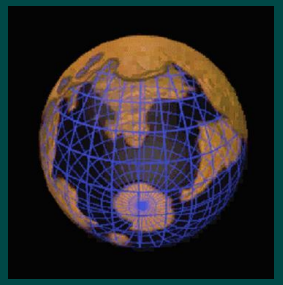
Real-Time Updating from any Location





Worldwide authentication & tracking

GPRS

Standard Labelling Carries Unique Identifier

In-Field Authentication

Conclusion

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At the moment the observer doesn’t have the resources to watch for very long

It is clear from current research activity in Industry and Universities that the amount of time the observer is actually watching is going to increase

It’s a new business sector so it is likely to expand

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